

WAKABAYASHI
Application No. 10/695,866
June 10, 2005

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (currently amended) An oil deterioration detection apparatus comprising:

a sensor that detects a characteristic of oil and produces a characteristic signal;

a malfunction detecting circuit that has a switch connected in parallel with the sensor;

an evaluation circuit that evaluates whether the oil is deteriorated based on the characteristic signal, which is detected when the switch is opened so that the malfunction detecting circuit is not electrically conducted in parallel with the sensor; and

a determination circuit that determines whether the sensor malfunctions based on the characteristic signal, which is detected when the switch is closed so that the malfunction detecting circuit is electrically conducted in parallel with the sensor;.

wherein the switch connects the malfunction detecting circuit in parallel with the sensor in a time period, and disconnects the malfunction detecting circuit from the sensor in another time period.

WAKABAYASHI
Application No. 10/695,866
June 10, 2005

2. (original) The oil deterioration detection apparatus according to claim 1,

wherein the malfunction detecting circuit has a resistor, the evaluation circuit evaluates whether the oil is deteriorated based on the characteristic signal when the switch is opened so that the resistor of the malfunction detecting circuit is not electrically conducted in parallel with the sensor, and

the determination circuit determines whether the sensor malfunctions based on a divided voltage in which a voltage of the characteristic signal is divided by the resistor when the switch is closed so that the resistor of the malfunction detecting circuit is electrically conducted in parallel with the sensor.

3. (original) The oil deterioration detection apparatus according to claim 1, further comprising:

a measurement circuit having an amplifier that is electrically connected between the sensor and the evaluation circuit and the determination circuit.

4. (original) The oil deterioration detection apparatus according to claim 1, wherein the malfunction detecting circuit is electrically conducted in parallel with the sensor for a certain period within an operation period of the oil deterioration detection apparatus so that the determination circuit determines

whether the sensor malfunctions.

5. (original) The oil deterioration detection apparatus according to claim 1, wherein the characteristic has acidity and basicity of the oil, and the sensor outputs the characteristic signal in response to the acidity and the basicity of the oil.

6. (original) The oil deterioration detection apparatus according to claim 1,

wherein the sensor includes a reference electrode that has a constant potential regardless of acidity and basicity in the oil, and a sensitive electrode in which an electric potential changes in response to the acidity and basicity in the oil, and

the sensor outputs a potential difference between the reference electrode and the sensitive electrode as the characteristic signal.

7. (original) The oil deterioration detection apparatus according to claim 1,

wherein a normal voltage is detected when the switch of the malfunction detecting circuit is opened so that the malfunction detecting circuit is not electrically conducted in parallel with the sensor,

a divided voltage is detected when the switch of the malfunction detecting circuit is closed so that the malfunction detecting circuit is electrically conducted in parallel with the sensor, and

the determination circuit determines whether the sensor malfunctions based on a relation between the normal voltage and the divided voltage.

8. (original) The oil deterioration detection apparatus according to claim 7,

wherein the determination circuit stores a certain range of a difference between the normal voltage and the divided voltage in advance in consideration of dispersion of a manufacturing of the sensor, and

the determination circuit determines that the sensor malfunctions when the relation between the normal voltage and the divided voltage is out of the certain range.

9. (original) The oil deterioration detection apparatus according to claim 8, wherein the certain range is adjustable based on the normal voltage.

10. (original) The oil deterioration detection apparatus according to claim 7, wherein the determination circuit determines that the sensor malfunctions when the normal voltage is less than a first threshold voltage or the normal voltage

is more than a second threshold voltage that is higher than the first threshold voltage.

11. (original) The oil deterioration detection apparatus according to claim 3, wherein the switch is closed so that the malfunction detecting circuit is electrically conducted to the measurement circuit when the determination circuit determines that the sensor malfunctions.

12. (original) The oil deterioration detection apparatus according to claim 11, further comprising:

a second switch that is connected between the sensor and the determination circuit so that a connection between the sensor and the determination circuit is conducted or not,

wherein the second switch is opened so that the connection between the sensor and the determination circuit is not conducted when the determination circuit determines that the sensor malfunctions.

13. (original) The oil deterioration detection apparatus according to claim 1, wherein the determination circuit is included in the evaluation circuit.

14. (original) The oil deterioration detection apparatus according to

claim 1, wherein the switch of the malfunction detecting circuit has a semiconductor switch.

15. (original) The oil deterioration detection apparatus according to claim 8, wherein the certain range increases with increasing the normal voltage.

16. (new) A method of detecting oil deterioration, the method comprising:

detecting a characteristic of oil and producing a characteristic signal via a sensor;

providing a malfunction detecting circuit that has a switch connected in parallel with the sensor;

evaluating whether the oil is deteriorated based on the characteristic signal detected when the switch is opened so that the malfunction detecting circuit is not electrically conducted in parallel with the sensor; and

determining whether the sensor malfunctions based on the characteristic signal detected when the switch is closed so that the malfunction detecting circuit is electrically conducted in parallel with the sensor;

wherein the switch connects the malfunction detecting circuit in parallel with the sensor in a time period and disconnects the malfunction detecting circuit with the sensor in a separate time period so that oil deterioration evaluation and

sensor malfunction detection can be performed in separate time periods.

17. (new) The method according to claim 16,
wherein the malfunction detecting circuit has a resistor,
evaluating whether the oil is deteriorated based on the characteristic signal
when the switch is opened so that the resistor of the malfunction detecting circuit
is not electrically conducted in parallel with the sensor, and
determining whether the sensor malfunctions based on a divided voltage in
which a voltage of the characteristic signal is divided by the resistor when the
switch is closed so that the resistor of the malfunction detecting circuit is
electrically conducted in parallel with the sensor.

18. (new) The method according to claim 16, wherein the
characteristic has acidity and basicity of the oil, and the sensor outputs the
characteristic signal in response to the acidity and the basicity of the oil.

19. (new) The method according to claim 16,
wherein the sensor includes a reference electrode that has a constant
potential regardless of acidity and basicity in the oil, and a sensitive electrode in
which an electric potential changes in response to the acidity and basicity in the
oil, and

WAKABAYASHI
Application No. 10/695,866
June 10, 2005

the sensor outputs a potential difference between the reference electrode and the sensitive electrode as the characteristic signal.

20. (new) The method according to claim 16,
wherein a normal voltage is detected when the switch of the malfunction detecting circuit is opened so that the malfunction detecting circuit is not electrically conducted in parallel with the sensor,
a divided voltage is detected when the switch of the malfunction detecting circuit is closed so that the malfunction detecting circuit is electrically conducted in parallel with the sensor, and
whether the sensor malfunctions is determined based on a relation between the normal voltage and the divided voltage.